

Integrating Efficient Anammox with Enhanced Biological Phosphorus Removal Process Through Floccs Management for Sustainable Ultra-deep Nutrients Removal from Municipal Wastewater

Authors : Qiongpeng Dan, Xiyao Li, Qiong Zhang, Yongzhen Peng

Abstract : The nutrients removal from wastewater is of great significance for global wastewater recycling and sustainable reuse. Traditional nitrogen and phosphorus removal processes are very dependent on the input of aeration and carbon sources, which makes it difficult to meet the low-carbon goal of energy saving and emission reduction. This study reported a proof-of-concept demonstration of integrating anammox and enhanced biological phosphorus removal (EBPR) by floccs management in a single-stage hybrid bioreactor (biofilms and floccs) for simultaneous nitrogen and phosphorus removal (SNPR). Excellent removal efficiencies of nitrogen ($97.7 \pm 1.3\%$) and phosphorus ($97.4 \pm 0.7\%$) were obtained in low C/N ratio (3.0 ± 0.5) municipal wastewater treatment. Interestingly, with the loss of floccs, anammox bacteria (Ca. Brocadia) was highly enriched in biofilms, with relative and absolute abundances reaching up to 12.5% and 8.3×10^{10} copies/g dry sludge, respectively. The anammox contribution to nitrogen removal also rose from $32.6 \pm 9.8\%$ to $53.4 \pm 4.2\%$. Endogenous denitrification by floccs was proven to be the main contributor to both nitrite and nitrate reduction, and floccs loss significantly promoted nitrite flow towards anammox, facilitating AnAOB enrichment. Moreover, controlling the flocc's solid retention time at around 8 days could maintain a low poly-phosphorus level of 0.02 ± 0.001 mg P/mg VSS in the floccs, effectively addressing the additional phosphorus removal burden imposed by the enrichment of phosphorus-accumulating organisms in biofilms. This study provides an update on developing a simple and feasible strategy for integrating anammox and EBPR for SNPR in mainstream municipal wastewater.

Keywords : anammox process, enhanced biological phosphorus removal, municipal wastewater, sustainable nutrients removal

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